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(54) BRAKE ACTUATING APPARATUS FOR A MULTIPLE DISC AIRCRAFT DISC BRAKE

(71) We, THE BENDIX CORPORATION, a corporation organized and existing under the laws of the State of Delaware, United States of America, of Bendix Center, Southfield, Michigan, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a brake actuating apparatus for a multiple disc aircraft disc brake.

In conventional aircraft multiple disc brakes having an annular pressure plate, it has been the practice to provide a plurality of circumferentially arranged spaced apart fluid pressure actuated pistons connected to actuate the brake upon demand and a plurality of circumferentially arranged spaced apart brake adjust and reset devices operatively connected to the pressure plate between the pistons for adjusting the axial position of the pressure plate to compensate for wear of the brake discs and permit retraction of the pressure plate to maintain a predetermined running clearance between discs upon release of the brake.

It has been found that such conventional brake piston and adjust and reset arrangements are not entirely satisfactory due to distortion of the annular pressure plate resulting from uneven force distribution thereon as a consequence of the spaced apart brake adjust and reset devices and the position of the same relative to the brake actuating pistons.

At least one known attempt has been made to combine the piston and adjust and reset apparatus to thereby place the same as well as the forces derived therefrom in coaxial relationship. Although such a combined piston and adjust and reset device has distinct advantages over the prior art devices it is not without certain undesirable features. It has been found that wear or other deterioration such as metal fatigue of the component members of the brake actuating piston and adjust and reset device is accelerated by wear and/or brake vibration which, in the case of exposure to the pressurized brake fluid, results in undesirable particle contamination of the working pressurized fluid. Another undesirable characteristic feature of many related prior art structures is a requirement for partial or complete disassembly of the disc brake structure to gain access to the brake actuating piston and adjust and reset mechanism for routine maintenance or repair of the same.

It is the object of the present invention to provide a brake actuating apparatus wherein the adjust and reset means is isolated from the pressurized fluid to avoid particle contamination of the pressurized fluid and wherein the component annular parts of the actuating apparatus are coaxially arranged in a compact relationship such that the working forces derived therefrom act through a common axis.

For this object, the present invention provides a brake actuating apparatus for a multiple disc aircraft disc brake, comprising a casing having a cavity therein, a piston slidably carried in said cavity and responsive to a pressurized fluid communicated to said cavity, adjust and reset means being also provided in said cavity characterized in that said piston is further slidably carried on a tubular section fixedly connected to the casing so as to define between said casing, said tubular section and said piston an annular chamber adapted to be supplied by said pressurized fluid, the adjust and reset means being coaxially arranged in said tubular section, and isolated from the pressurized fluid.

According to a preferred embodiment of

the invention, the adjust and reset means comprise a first tubular member, said tubular section defining first and second axially spaced stop means, resilient means normally urging said tubular member against the first stop means on brake release, said tubular member carrying a deformable tubular member through which extends a stem member secured at one end to said piston and having an annular head engaging the internal wall of said deformable tubular member to define a predetermined force resisting axial relative movement between the stem member and the deformable tubular member, said force being greater than the force defined by the resilient means.

The invention will be now described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic representation of a wheel and brake assembly embodying the present invention,

Figure 2 is a sectional view of the present invention shown removed from the wheel and brake structure of Figure 1 and drawn in enlarged form,

Figure 3 is a sectional view taken on line 3—3 of Figure 2.

Referring to Figure 1, numeral 10 designates a conventional wheel and brake assembly including two annular wheel half portions 12 and 14, only one of which is shown in cross section. The wheel portions 12 and 14 are each provided with a tire retaining flange portion 16 for retaining a tire, not shown, thereon. A plurality of circumferentially spaced apart bolt and nut combinations 18 serve to fixedly secure the wheel portions 12 and 14 together. The wheel portion 12 is rotatably carried on a fixed axle 20 by conventional bearing means 22 interposed between a hub portion 24 and axle 20.

A rotatably fixed annular brake carrier or casing 26 suitably keyed to fixed axle 20 by splines 28 is provided with a plurality of circumferentially spaced apart open ended chambers or cavities 30 only one of which is shown in Figure 1. An annular torque tube 32 is fixedly secured to brake carrier 26 by a plurality of circumferentially spaced apart bolts 34, only one of which is shown, extending through the carrier 28 into threaded engagement with the torque tube 32. The torque tube 32 is provided with an integral annular brake backing plate 36 having an annular section of friction material or lining 38 fixedly secured thereto.

A plurality of annular brake stator members 40 are interleaved with a plurality of annular brake rotor members 42. The brake stator members 40 are each provided with lining 44 fixedly secured to opposite sides thereof and are suitably keyed as at 46 for axial movement on torque tube 32. The rotor members 42 are suitably keyed for axial movement to a spline member 48 which, in turn, is fixedly secured to wheel portion 12. The interleaved or stacked rotors 42 and stators 40 are adapted to be compressed together between the backing plate 36 and a movable pressure plate 50 to provide the desired braking or retardation of the wheel. The pressure plate 50 has lining 52 fixedly secured thereto and is suitably keyed as at 54 for axial movement on torque tube 32.

The actuating force imposed on the pressure plate 50 tending to compress the rotors and stators 42 and 40 together is derived from a plurality of pressurized fluid responsive motor assemblies 56 embodying the present invention secured in chambers 30 and responsive to pressurized fluid conducted to each chamber 30 via passage means including a passage 58 from a conventional operator controlled pressure source, not shown.

As shown in Figure 2, the motor assemblies 56 each include an annular member 59 provided with a threaded outer wall portion 60 and a flange portion 62 extending radially outwardly therefrom. The carrier 26 is suitably threaded at one end of each cavity 30 to receive the wall portion 60. The flange portion 62 is suitably formed to be engaged by conventional tool means (not shown) for rotating the annular member 59 into position. A flexible seal 63 compressed between flange portion 62 and carrier 26 serves as a seal against fluid leakage therebetween. A sleeve 64, slidably received by cavity 30, is provided with an enlarged diameter section 66 adapted to bear against a shoulder 68 formed in the wall of cavity 30. The enlarged diameter section 66 is suitably recessed to receive an "O" ring seal 70 which provides a fluid seal between adjacent surfaces of sleeve 64 and wall of cavity 30.

The adjust and reset means will now be described. The wall portion 60 is adapted to telescope over the adjacent end wall of sleeve 64 to the extent that the end of sleeve 64 which faces the flange portion 62 bears against an annular wall portion 72 extending from wall portion 60 to a reduced diameter tubular section 74 having a spaced apart relationship with sleeve 64 coaxial therewith. The wall portion 60 and sleeve 64 preferably have a press fit. A piston 75 having a skirt section 76 and a base section 78 is arranged to telescope on tubular section 74. The skirt section 76 is provided with an enlarged diameter portion 80 suitably recessed to receive an "O" ring seal 82 which resists fluid leakage between portion 80 and sleeve 64. The tubular section 74 is suitably recessed to receive an

"O" ring seal 83 which resists fluid leakage between skirt section 76 and tubular section 74. The skirt section 76 is adapted to abut wall portion 72 when the piston 75 is retracted as shown. The piston 75 is responsive to pressurized fluid conducted to the annular end area of skirt portion 76 via a plurality of openings 84 in sleeve 64, an annular chamber 86 between carrier 26 and sleeve 64 and a passage 87 in carrier 26 which passage 87 is connected to receive pressurized fluid from the operator controlled source (not shown).

The base section 78 is provided with a mating block of suitable heat insulation material 90 held in place by a retaining cap 92. The retaining cap 92 is provided with flexible side wall portions 96 adapted to slide over piston 75 to thereby retain block 90 in position. A conventional flexible seal or dust boot 98 having opposite end portions suitably formed to snap into annular recesses 100 and 102 formed in skirt section 76 and sleeve 64, respectively, serves to exclude dirt or other debris from the interior wall of sleeve 64 against which the skirt section 76 slides. The cap 92 is provided with an annular shield 104 extending radially therefrom to shield seal 98 from pressure plate 50.

A stem or rod 106 extending through a rectangular-shaped opening 108 in base section 78 has a generally rectangular-shaped head 110 trapped in a rectangular-shaped recess 112 in base section 78 by the block 90. The stem 106 is adapted to be disengaged from base section 78 by moving stem 106 axially relative to piston 75 to disengage head 110 from recess 112 whereupon the stem 106 is rotated to align head 110 with opening 108 and withdrawn from base section 78. The stem 106 may be attached to base section 78 in a similar manner but reverse sense. The stem 106 is coaxial relative to piston 75, tubular section 74 and sleeve 64 and includes a threaded end 114 adapted to receive an annular head or button 116 threadedly engaged therewith. The button 116 bears against a shoulder 118 formed on stem 106 and is locked in position thereagainst by a lock nut 120 threadedly engaged with end 114. The radial outer surface of button 116 is curved to permit button 116 to slide along a tube 122 as will be described.

The radially deformable tube 122, preferably made of metal capable of plastic deformation under a predetermined force load, surrounds stem 106 coaxial therewith and is provided with an inner diameter slightly smaller than the button 116 diameter. The inner surface of tube 122 is engaged by button 116 which is forcibly gripped by tube 122 at any given position of button 116 therein. A tubular member 124 coaxial with tube 122 and in radially spaced apart relationship thereto has a radially outwardly extending annular flange 126 on one end and a reduced diameter opposite end provided with an annular recess 128. The tubular member 124 is attached at one end to tube 122 by virtue of a slip fit in recess 128. A compression spring 130 surrounding tubular member 124 and coaxial therewith is interposed between an annular radially extending shoulder 132 formed on tubular section 74 and a washer 134 bearing against flange 126 resulting in axial retraction of tubular member 124 and tube 122 as well as stem 106, by virtue of engagement of button 116 with tube 112, and a piston 75. The extent to which the above members are retracted by spring 130 is defined by an annular snap ring member 136 removably secured in a mating annular recess 138 formed in the wall of an enlarged diameter section 140 of annular member 59 which section 140 terminates in an annular shoulder 142. The shoulder 142 is engaged by washer 134 to thereby limit movement of the latter away from snap ring 136 during a brake application as will be described. The range of axial movement of annular member 126 permitted by snap ring 136 and shoulder 142 which act as stops establishes a predetermined brake clearance upon retraction of the pressure plate 50. The annular head or button 116 engages the internal wall of the tube 122 in such a way as to define a predetermined force resisting axial relative movement between the stem 106 and the tube 122, this force being greater than that defined by the compression spring 130.

The brake is energised upon an increase in pressure of the fluid supplied to passage 87 from which it passes via chamber 86 and openings 84 to the annular end of skirt section 76. Each of the pistons 75 are simultaneously pressurized in the above manner resulting in movement of pressure plate 50 toward backing plate 36 between which the rotors and stators 42 and 40 are adapted to be compressed. The tubular member 124 being secured to piston 75 via tube 122, button 116 and stem 106 moves with piston 75 thereby compressing spring 130 until washer 134 engages shoulder or stop 142 whereupon the tubular member 124 is fixed in position. Assuming the pressure plate 50 has failed to move to the extent required to fully engage rotors and stators 42 and 40 as a result of brake lining wear, the piston 75 will continue to move in response to the pressurized fluid applied against skirt section 76. The button 116 is urged via stem 106 by piston 75 axially against the resistance of tube 122 which is deformed radially outwardly permitting the piston 75 and pressure plate 50 to advance

accordingly until full engagement of the rotors and stators 42 and 40 is attained.

The brake is released upon depressurization of the skirt section 76 which results in retraction of piston 75 under the influence of spring 130 since the button 116 is gripped by tube 122 as a result of the plastic deformation of tube 122. The retraction of piston 75 is limited to the extent provided by snap ring 136 which is engaged by washer 134 thereby establishing the desired predetermined running clearance of rotor and stator members 42 and 40.

The axial movement of button 116 through tube 122 continues as necessary to compensate for wear of the linings 38, 44 and 52 upon application of the brake. Upon reaching the reduced diameter end of tubular member 124 provided with annular recess 128 the button 116 is prevented from further movement relative to tube 122 thereby necessitating overhaul of the adjust and reset portion of motor assembly 56. It will be recognized that the range of movement of button 116 in tube 122 will correspond to the permissible cumulative axial wear of the linings 38, 44 and 52.

It will be noted that the spring 130, tubular member 124, tube 122, button 116 and stem 106 are not exposed to the pressurized fluid which actuates piston 75 thereby avoiding contamination of the pressurized fluid with particles of metal which may result from movement of the varous members of the adjust and reset apparatus. The spring 130, tubular member 124, tube 122, button 116 and stem 106 are exposed to ambient air.

The radial clearance between spring 130 and tubular section 74 as well as tubular member 124 is reduced to a minimum to minimize radial vibration of the spring 130. Also, the radial spacing between the various members such as tube 122 relative to tubular section 74 and tubular member 124 relative to tubular section 74 is minimized to present a compact arrangement of these members within piston 75

Removal of the entire motor assembly 56 is a relatively simple matter since it may be extracted from carrier 26 without disturbing the remaining brake elements. The piston 75 is forced away from pressure plate 50 by a suitable tool, not shown such as a pry bar or the like causing skirt section to seat against wall portion 72 whereupon cap 92 may be disengaged from piston 75 and end portion of boot 98 disengaged from recess 100. The annular member 59 is unscrewed from carrier 26 and sleeve 64 withdrawn from cavity 30 on the external side i.e. side opposite to pressure plate side of carrier 26 thereby removing the entire motor assembly 56. The assembly 56 is completely disassembled by forcing piston 75 toward wall portion 72 to seat skirt section 76 against the latter resulting in disengagement of tube 122 from recess 128 or displacement of button 116 toward the free end of tube 122. The lock nut 120 and snap ring 136 are removed to permit removal of button 116. and tubular member 124 following which the stem 106 may be rotated to disengage the end thereof from base section 78. The piston 75 can be withdrawn from sleeve 64 and tubular section 74. Assembly may be accomplished by reversing the above-mentioned sequence.

Partial disassembly in the event of a broken stem 106, for example may be made with minimum disturbance of parts. To that end, the piston 75 may be forced away from pressure plate 50 to permit sufficient room to slide retaining cap 92 axially relative to piston 75 and partially withdraw block 90 from recess 88. Obviously, a broken stem 106 does not require removal of lock nut 120 to permit removal of tube 122 which may be disengaged from recess 128 and withdrawn. The stem 106 may then be urged toward block 90 to clear recess 112 and rotated to a position permitting withdrawal of head 110 through opening 108. A new stem 106 and tube 122 may be inserted by reversing the above-mentioned steps following which a button 116 is positioned on stem 106 and locked in position thereon by lock nut 120. The lock nut 120 may be secured in position by suitable wire means 144 if desired.

WHAT WE CLAIM IS:—

1. A brake actuating apparatus for a multiple disc aircraft disc brake, comprising a casing having a cavity therein, a piston slidably carried in said cavity and responsive to a pressurized fluid communicated to said cavity, adjust and reset means being also provided in said cavity wherein said piston is further slidably carried on a tubular section fixedly connected to the casing so as to define between said casing, said tubular section and said piston an annular chamber adapted to be supplied by said pressurized fluid, the adjust and reset means being coaxially arranged in said tubular section, and isolated from the pressurized fluid.

2. A brake actuating apparatus according to claim 1, wherein said adjust and reset means comprise a first tubular member, said tubular section defining first and second axially spaced stop means, resilient means normally urging said tubular member against the first stop means on brake release said tubular member carrying a deformable tubular member through which extends a stem member secured at one end to said piston and having an annular head engaging the internal wall of said deformable tubular member to define a predetermined force

resisting axial relative movement between the stem member and the deformable tubular member, said force being greater than the force defined by the resilient means.

3. A brake actuating apparatus according to claim 2, wherein said resilient means is a compression spring.

4. A brake actuating apparatus according to claim 3, wherein one end of said compression spring bears against a washer bearing against the first tubular member, the other end of the compression spring bearing against a radially extending shoulder provided on said tubular section.

5. A brake actuating apparatus according to claim 4, wherein said washer is adapted to engage said first and second stop means.

6. A brake actuating apparatus according to any one of claims 2 to 5, wherein the first stop means is an annular ring member removably secured to said tubular section, the second stop means being an annular shoulder formed on said tubular section.

7. A brake actuating apparatus according to any one of claims 2 to 6, wherein said stem member is removably secured to said piston to permit withdrawal of the stem member from the piston.

8. A brake actuating apparatus according to any one of claims 2 to 7, wherein said annular head is removably secured to the free end of the stem member by a lock nut threadedly engaged with the free end of said stem member.

9. A brake actuating apparatus according to any one of the preceding claims wherein a sleeve member is disposed in said cavity in radially spaced apart relationship to said tubular section, said piston having a skirt portion slidably engaged with said sleeve member and said tubular section and provided with a base portion.

10. A brake actuating apparatus according to any one of the preceding claims, wherein the tubular section defines a portion of an annular member further comprising an outer wall portion threadedly and sealingly engaged with said casing.

11. A brake actuating apparatus for a multiple disc aircraft disc brake substantially as described and as illustrated with reference to the accompanying drawings.

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1515239 COMPLETE SPECIFICATION
2 SHEET *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

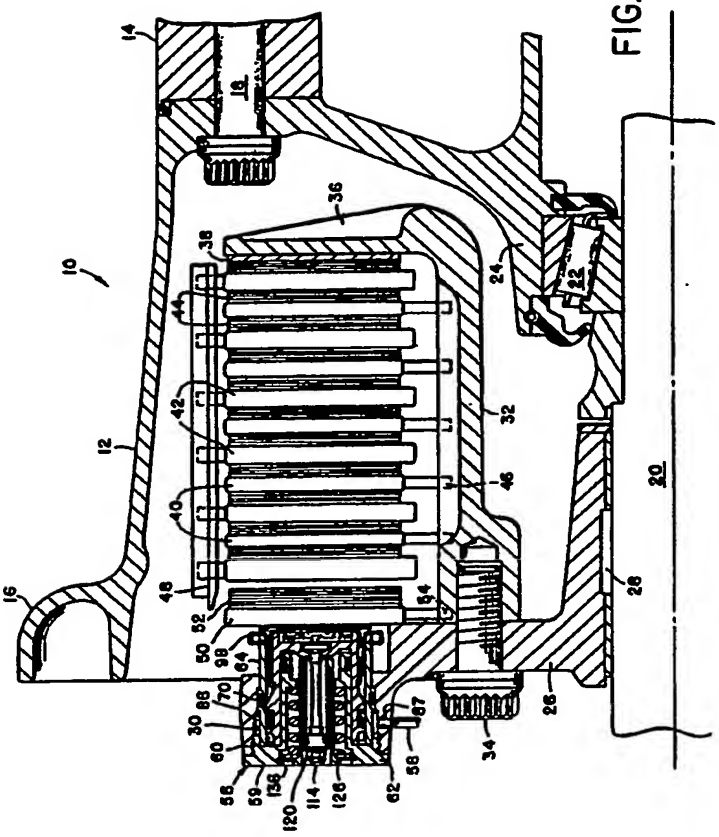

FIG. 1

1515239
2 SHEETS

COMPLETE SPECIFICATION

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Sheet 2

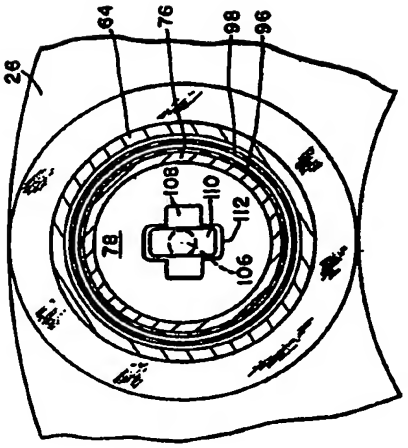

FIG.3

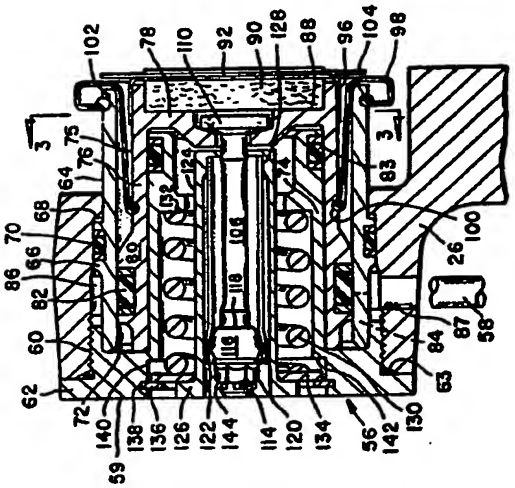

FIG.2